NDCEE

National Defense Center for Energy and Environment

Zero Energy Housing for Military Housing Design Approach Case Study: Ft. Campbell

Ms. Heidi Anne Kaltenhauser, NDCEE/*CTC*

DoD Executive Agent

Office of the Assistant Secretary of the Army (Installations and Environment)

The NDCEE is operated by: *CTC* *Concurrent Technologies Corporation*

Presentation Overview

- Project Objective And Drivers
- Project Evolution (Phase I and II)
- Project Team and Approach
- Design Approach
- Energy Modeling Results
- Path Forward

OBJECTIVE: Help the DoD build cost-effective, energy-efficient housing. As a step towards achieving this, the NDCEE is assisting with the design and evaluation of the performance of ZEH for military installations.

Project Drivers

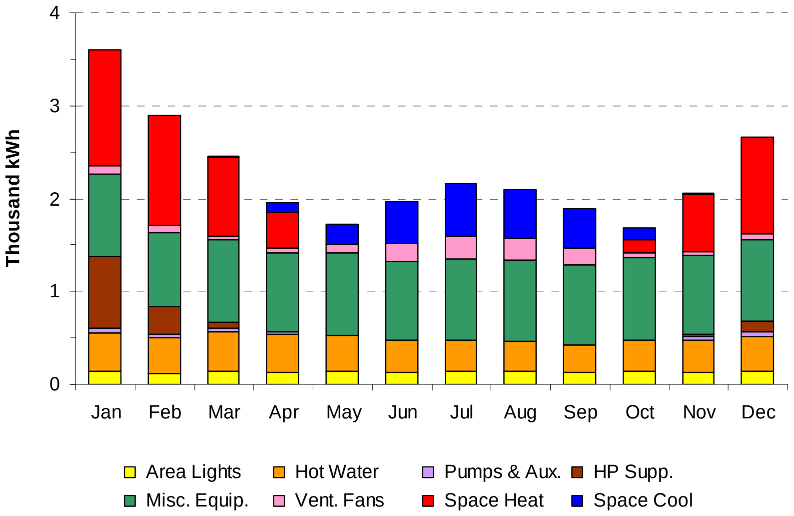
- In FY06, 300,000 DoD homes used 11 trillion BTUs of electricity at a cost of $254M
- Military Housing Privatization Initiative of 1996 provides opportunity for private expertise/capital to be used for military housing (DoD is privatizing 195,000 homes by 2010)
- Executive Order 13423, Energy Policy Act of 2005, and Army policy require more energy-efficient/less polluting buildings
- Energy efficiency leads to reduced electricity use and costs, increased energy security, supply stability, reduced greenhouse gases, and improved living environment
- Work is transferable across all Services and into the private sector

Phase I: NDCEE Sustainable Installations Initiative

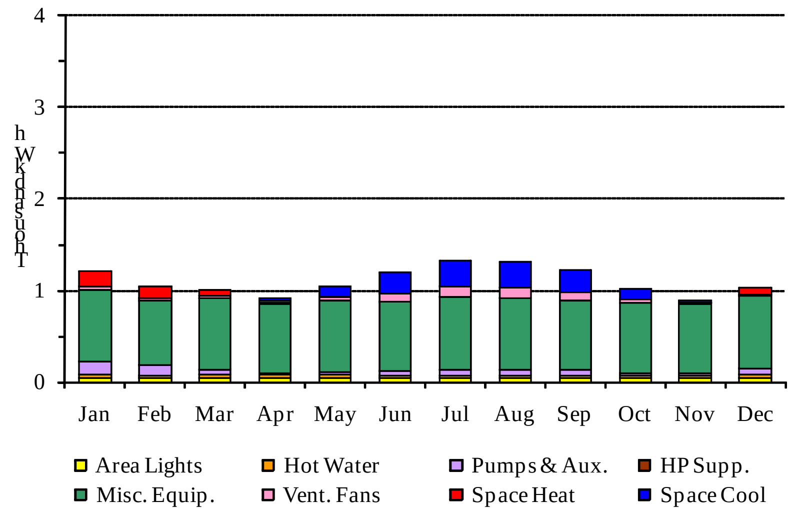
- Establish baseline energy usage (eQUEST computer simulation)
- Validate results:
  - Quantity: metering data
  - System Usage: US DOE Residential Energy Survey Data
- Design charette to identify alternative technologies
- Evaluate alternative technologies to optimize technology portfolio (eQUEST)

Phase I Results

- Expected energy requirements
  - Reduced by 51%,
  - saving $800/home annually
  - Potential for $3.5M annual savings base wide



Baseline: 27,100 kWh/year



Alternative Design: 13,200 kWh/year

Phase II: ESTCP Funded

- Use integrated design and energy modeling to demonstrate zero energy housing.
- Validate the potential to provide cost effective zero energy housing.
- Transfer project knowledge DOD-wide and beyond.

ESTCP Project Team

Stakeholders

Environmental Security Technology Certification Program (ESTCP)
US Army Installation Management Command Southeast (IMCOM SE)

Team Members

National Defense Center for Energy and Environment (NDCEE)
Fort Campbell
Fort Campbell Family Housing
Actus Lend Lease
Pacific Northwest National Laboratory (PNNL)
National Association of Home Builders Research Center (NAHB-RC)
7- Group
Luckett and Farley

Project Approach

- Design
  - Establish Approach and Methods
  - Delineate Constraints
  - Establish Baseline
  - Establish Initial Energy Efficiency Design
  - Modeling of Charrette Technologies
  - Final Design
- Construction
- Monitoring
- Technology Transfer

Design Approach and Methods

- Held design team teleconferences to begin to:
  - set performance goals
  - identify specific technologies, tools, and strategies.
- Held Two-day design charrette with multi-disciple, multi-organizational team
- Tools used:
  - Integrated Design: Replaces the traditional sequential design process by integrating multiple disciplines early in the process to help identify and optimize systems and reduce overall costs
  - Energy modeling and analysis
  - Life-cycle cost analysis

Constraints

- Street exterior to be unaltered
- Baseline and ZEH to be placed in existing development plan
- Occupants historically not responsible for utilities
- Work within existing floor plan

Baseline Design

- Duplex
- Four-bedroom
- Two-story dwelling
- 1,985 square feet of conditioned space per unit
- 2.5 baths
- Energy Star Rating

Photo courtesy of Luckett & Farley.

Baseline Design Parameters
Building Envelope

Foundation Type	SOG
Slab Floor R-value	5
Flat Ceiling R-value	49
Floor R-value, Over Garage	19
Wall R-value	15
Wall Area, Above Grade (ft^2)	2,616
Window U-value	0.35
Window SHGC	0.33
Glazing Area (ft^2)	220
Window Area % of Floor	11.39%
Window Area % of Wall	8.44%
Ventilation Rate, cfm	57
Duct Loss %	12%
Insulating Sheathing R-value	0.5
Infiltration, ACH	0.2

Energy Star Features

Baseline Design Parameters Systems

Cooling System (EE with GSHP)	13 SEER
Cooling Capacity, kBtu/hr, approximate	36
Heating System, HSPF (EE with GSHP)	7.7 HSPF
Heating Capacity, kBtu/hr, approximate	36
Duct Loss %	12%
Water Heater Energy Factor	0.92
Hot Water Use, gallons/day*	74

* Building of America Guidelines

Baseline Design Parameters Internal Loads

Based on research done to develop the Building America program sponsored by the U.S. Department of Energy – end-use for residential buildings*

Use	kWh
Clothes Washer	123
Dishwasher	240
Dryer	974
Lighting	2358
Miscellaneous	3377
Range	706
Refrigerator	669

Model parameters:

- Annual energy use
- Hourly profile for daily usage
- Sensible and latent heat load, if applicable

* Robert Hendron, Building America Research Benchmark Definition, Updated December 20, 2007, National Renewable Energy Lab, NREL/TP-550-42662, January 2008.

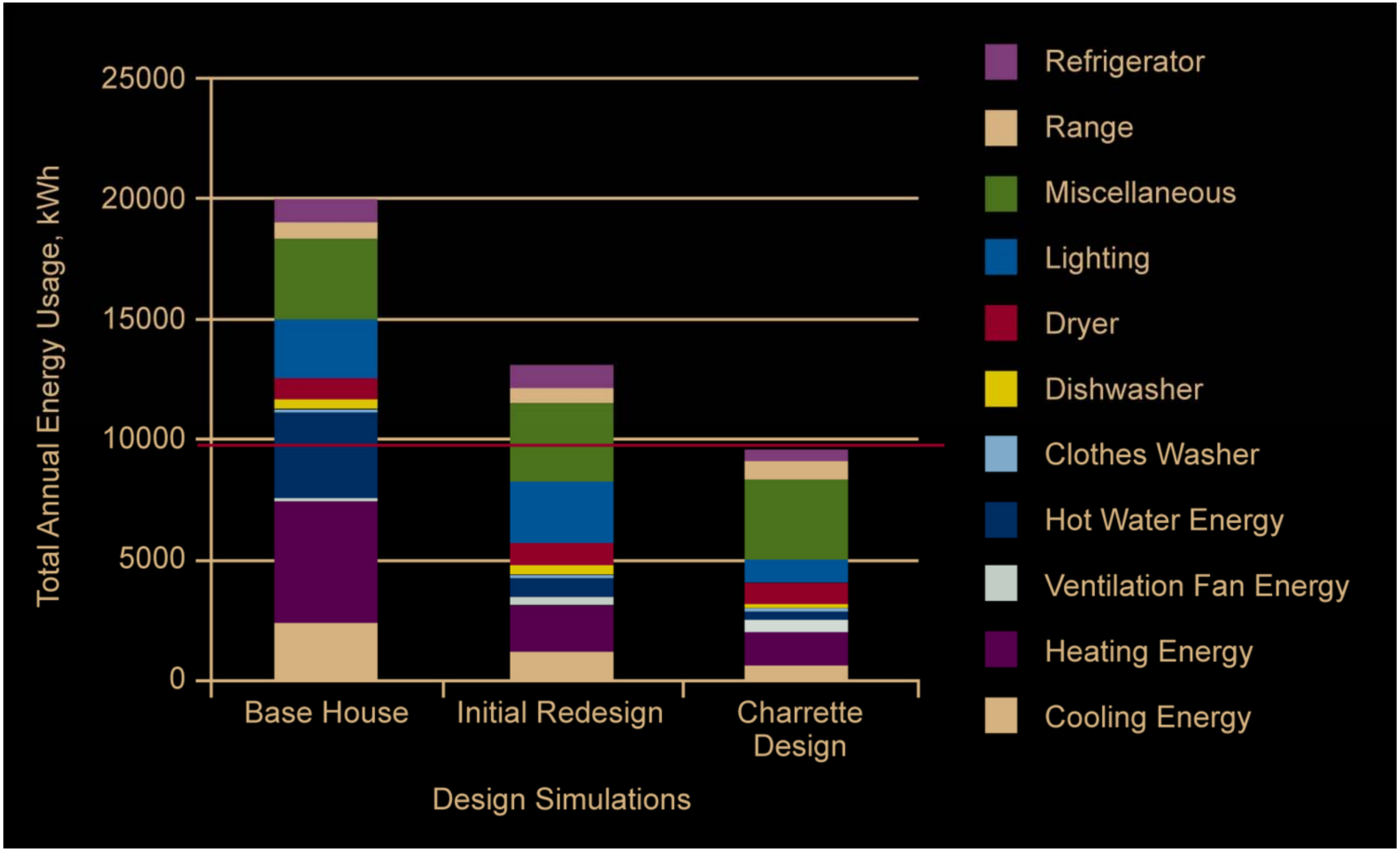
Initial Energy Efficient Design

Parameter	Baseline Design	EE Design
Slab Floor R-value	5	10
Floor R-value, Over Garage	19	30
Insulating Sheathing R-value	0.5	10
Infiltration, ACH	0.2	0.1
Cooling System (EE with GSHP)	13 SEER	14.1 EER
Cooling Capacity, kBtu/hr, approximate	36	24
Heating System, HSPF (EE with GSHP)	7.7 HSPF	3.3 COP
Heating Capacity, kBtu/hr, approximate	36	24
Duct Loss %	12%	8%
Water Heater Energy Factor	0.92	0.98

Major Design Elements

Design Feature	Details
Building Orientation	Rear facing due south
2x6 wood stud, 1" exterior sheathing, cellulose or foam in wall cavity	• R19+ cavity insulation, • Preferred blown cavity, • R5 (1”) exterior sheathing, • 20% or less framing fraction (OVE details) • Wall and cavity sealing details will be necessary
Floor over garage	R-30 batt or blown
Attic	• Frame using raised heel truss • Air seal details at top plates • R-60 blown insulation
Windows	• Maximum U-value - 0.31 • Maximum SHGC - 0.32
Infiltration	Less than 2.0 ACH50
Ventilation	57 cfm per ASHRAE Standard
Heating and Cooling - Ducts	• Mastic seal all ducts • Insulate ducts in floor space • All ducts and equipment in conditioned space
Heating and Cooling - Plant	Ground source heat pump technology – 18 EER and 4.0 COP
Domestic Hot Water	• Centralized tank • Hot water manifold distribution • Solar thermal preheat, 64-80 sq. feet collector • 120 gallon storage tank with integral 4,500 W element
Appliances and Lighting	• 100% fluorescent interior and exterior • Energy Star minimum appliance ratings • Controlled power strips • Bath fans with timer switches

Modeling Results



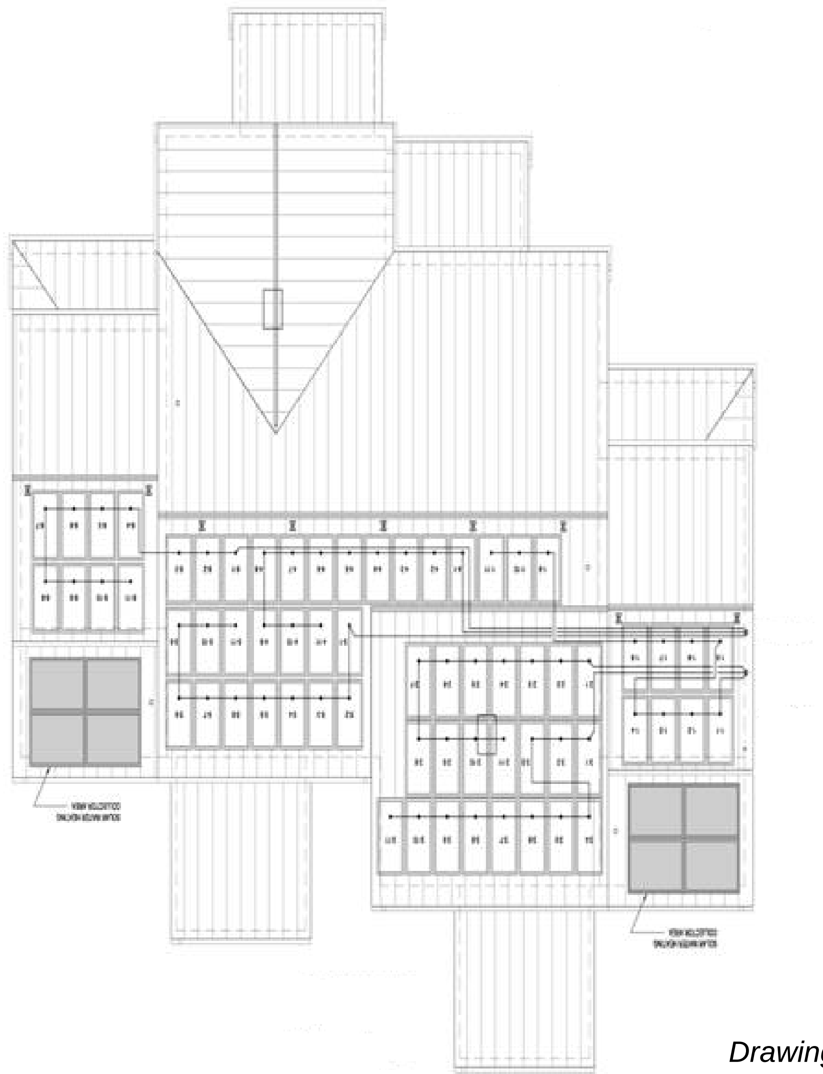
Initial Exterior Design

Redesign of South facing roof provides space for solar water heating and photovoltaics

Replace gables and hip with shed; added porch roofs

Final Roof Design with PV Array

- 6 Strings of 11 panels in series
- 33 – 225 W panels per unit
- 7,425 W per unit
- 14,850 W total



Drawing Courtesy of Luckett and Farley

Next Steps

- Construction and Monitoring
  - Includes occupant education program
  - Commissioning
- Performance Validation
  - Energy consumption, cost, and use patterns
  - Environmental impacts
  - On-site energy production
  - Maintenance costs and labor-hours
  - Occupant comfort and satisfaction
  - Lifecycle cost, net present value, simple payback, and
  - Return on Investment (ROI) analysis

Final Steps

- Technology Transfer
  - Present results at energy and construction industry conferences
  - Produce case study
  - Develop ESTCP reports
  - Incorporate lessons learned into over 40,000 military housing units that Actus Lend Lease is building nationwide

Project Contacts

- Manette Messenger, IMCOM SE, 404-464-0786, manette.messenger@us.army.mil

- Heidi Anne Kaltenhauser, NDCEE/*CTC*, 502-897-7815, kaltenha@ctc.com

This work was funded through the Environmental Security Technology Certification Program (ESTCP) and conducted under contract W74V8H-04-D-0005 Task 0509.